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EDITORIAL

SPECIAL SECTION

Advances in electrical power engineering

Ł. NOGAL [1], S. ROBAK [1], and J. BIALEK [2]

[1] Warsaw University of Technology, pl. Politechniki 1, 00-661, Warsaw, Poland
[2] Newcastle University, Newcastle upon Tyne NE1 7RU, United Kingdom

Electrical power engineering is one of the earliest research fields that has developed in electrical engineering. It deals with the generation, transmission, and distribution of electric power, considering the issues of efficient and economical use of energy resources. Due to climate change, environmental protection, and the depletion of mineral energy resources, the electric power systems of the future must deal with new challenges. For these reasons, electrical power engineering development does not stand still and currently is driven by the issues such as smart power grid, renewable energy sources integration, storage system, IT and communications technologies, apparatus and devices design, power and voltage control, and enhancement of security of electric power systems [1–3].

This special section "Advances in electrical power engineering", on the one hand, has been prepared to present progress in state of the art and to emphasize emerging research topics. On the other hand, the special section has been initiated in the light of the 50th anniversary of the Electrical Power Engineering Institute at Warsaw University of Technology. Although the Institute was formally established in 1970, research and education in the field of electrical power engineering were developed from the beginning of Warsaw University of Technology. Today, in a competitive world, Electrical Power Engineering Institute conducts interdisciplinary research that uses knowledge of electrical engineering, electronics, automation and control, IT, telecommunication engineering and mechanical engineering.

This Special Section of the Bulletin of the Polish Academy of Sciences on Technical Sciences is devoted to the present rapid progress in interdisciplinary scientific research in the field of electrical power engineering. The section presents the results of research obtained using knowledge of electrical engineering, automatic control, computer science, telecommunications, and mechanical engineering to solve current scientific and technical problems. The papers included in the presented special section of the Bulletin are grouped into three main categories: smart grid, efficient energy use, and apparatus and devices design.

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1. Papers devoted to smart grid

Papers [4–6] are related to smart grids, and are devoted to the issue of microgrids.

The paper co-authored by A. Cagnano, E. De Tuglie, F. Marcone, G. Porro, and D.D. Rasolomampionona [4] presents a control strategy for real-time operation of a master-slave controlled microgrid. The proposed control strategy allows to schedule all dispatchable energy sources available into a microgrid to minimize its operational costs. Control decisions are made centrally by the system, whose operation is based on the solution of a two-stage optimization problem. Considered timescales of control problem are day-ahead and in real-time.

The paper co-authored by M. Parol, P. Kapler, J. Marzecki, R. Parol, M. Połecki, and Ł. Rokicki [5] presents distributed control, combining the effects of distributed cooperative control and modified Monte Carlo optimization in the case of rural low voltage microgrids. Different objective functions for optimization process have been analyzed. Moreover, different scenarios for microgrid control system action with respect to communication loss have also been presented.

The paper co-authored by A. Moulichon, V. Debusschere, L. Garbuio, M. A. Rahmani, M. Alamir, and N. Hadjsaid [6] is related to the topic of smart grids, too. The paper discusses a virtual synchronous generator and suggests a set of inverter tests. Inverters are supposed to work in a friendly way for isolated microgrids. The paper presents a virtual synchronous generator model and its application in an industrial inverter controller. The application of the proposed solution when utilised in large projects is presented. To determine the necessary directions of their development, requirements for future network-friendly generators based on inverters are defined. The conducted tests are aimed at ensuring that once the proposed standards are met, each virtual generator solution can be integrated into the microsystem.

The paper co-authored by K. Kurek, Ł. Nogal, R. Kowalik, and M. Januszewski [7] presents software power protection tester that might replace conventional testing setups. The main contribution of the paper is an algorithm of multithreaded tester operation. The presented solution shows that it is possible to

implement protection devices in the form of programs inside the Linux operating system and to realize the protection functions in a virtualized environment using Linux RT.

The paper co-authored by P. Piotrowski, D. Baczyński, S. Robak, M. Kopyt, M. Piekarz, and M. Polewaczyk [8] presents three variants of e-mobility development and its impact on the Polish Power System. In particular, the paper shows an approach to forecasts of daily energy demand profiles for two characteristic days. The considered approach uses both proprietary power demand forecasts for a given year and forecasts of the shapes of the relative profiles.

2. Papers devoted to energy efficiency

The paper co-authored by P. Pracki A. Wiśniewski, D. Czyżewski, R. Krupiński, K. Skarżyński, M. Wesołowski, and A. Czapliski [9] presents design strategies and other factors that influence lighting conditions and energy efficiency of lighting solutions. The paper includes a comprehensive literature overview, which can be useful in analyzing and designing interior lighting, road lighting and floodlighting. The obtained results are important for planning and implementing strategies for improving lighting conditions and energy efficiency of any lighting solution.

The paper co-authored by M. Bartecka, P. Terlikowski, M. Kłos, and Ł. Michalski [10] presents a study of a hybrid energy system under the Polish law and economic conditions for a self-government unit, which is legally obliged to apply means of energy efficiency improvement. The main contribution of the paper is a simple algorithm to find optimal hybrid PV and wind power source sizing for a prosumer. In the paper, the authors have included two different methodologies applied to solve the aforementioned optimization problem. The first approach is heuristic and based on monthly energy balancing, while the second is iterative and considers hourly energy balance.

The paper co-authored by W. Jefimowski, A. Nikitienko, Z. Drążek, and M. Wieczorek [11] presents the possibility of control of stationary supercapacitor energy storage systems using the variable minimum state of charge. The paper proposes to divide the state of charge curve into equal periods of time during which the minimum states of charge are constant. To predict the state of charge level for the following period, a learning algorithm based on the neural network has been proposed. The architecture and activation function of the neural network are presented. The paper shows that the use of the variable minimum state of charge ensures an increase of the recovered energy volume by approximately 10%.

3. Papers devoted to apparatus and devices design

The first example of a paper in this group is [12] co-authored by W. Żagan, S. Zalewski, S. Słomiński, and K. Kubiak. The paper presents modern methods of designing optical systems for luminaires in the context of the long-term development of light sources. It shows that the development of the production technology of increasingly precise optical systems has led to the evolution in the construction of luminaires with increasing efficiency and more effective use of the features of a specific family of light sources. The paper also presents methods of modelling features of light sources, in particular luminance, to make precise simulation calculations required in each light source design process. The paper includes the results of simulation calculations and laboratory measurements for a selected luminaire case.

The paper co-authored by T. Daszczyński, Z. Pochanke, and Ł. Kolimas [13] presents the application of a unique approach to the study of time and current characteristics of fuses. Functional properties of some electrical devices are expressed in the form of dependence between parameters determining a given aspect of a device duty or work circumstances, e.g. breakdown voltage – contact distance for the breaker, current – voltage for voltage limiters or response time – load current for overcurrent protection. Such properties are obtained experimentally, usually in a set of test series. The paper presents a way to reduce the number of tests, which may consist of defining the characteristics not as serial points but as an analytical function, a function with specific parameters, aggregating the results of all tests in one data set.

The paper co-authored by T. Maciołek, M. Lewandowski, A. Szeląg, and M. Steczek [14] presents the results of analyses and studies concerning the influence of pantograph contact losses on the supply conditions of vehicles supplied with 3 kV DC. These contact losses accelerate wear and tear of vehicles' drive systems. The paper presents the results of tests of voltage and current oscillations measured under real conditions. Next, a simulation model of a vehicle with AC motors and voltage converters was derived to conduct simulation experiments verifying the operation of such a vehicle in a near real state.

The paper authored by M. Borecki [15] examines the model of reliability assessment on the example of a power grid element. The tests were performed to check the reliability of power grid elements and to assess the change in the reliability level as a function of the inspection frequency. The results of the tests are aimed at determining the optimum frequency of inspections of individual power grid objects to increase its reliability. Interesting results have been obtained because optimization of the inspection frequency reduces operating costs while improving the operation of power system elements.

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Łukasz Nogal was born in Warsaw, Poland, in 1982. He obtained his M.Sc., Ph.D. and D.Sc. degrees in Electrical Engineering from the Faculty of Electrical Engineering, Warsaw University of Technology (WUT), Poland, in 2006, 2009, and 2014, respectively. He is currently Deputy Director for Science in Electrical Power Engineering Institute, WUT. Łukasz Nogal has authored more than 30 peer-reviewed journal and conference publications and chapters in several textbooks on electrical engineering. His current research interests include wireless power transfer, power system restoration strategies, flexible ac transmission systems, high-voltage dc, telecommunication systems and power system protection.

e-mail: Lukasz.Nogal@ien.pw.edu.pl

Sylwester Robak obtained his M.Sc. (1996), Ph.D. (1999) and D.Sc. (2008) degrees in Electrical Engineering from the Faculty of Electrical Engineering, Warsaw University of Technology (WUT), Poland. He has been associated with Warsaw University of Technology since 1999. From 2008 to 2012, he was Deputy Director of the Electrical Power Engineering Institute, WUT. In 2012–2016, he was Vice-Dean of the Faculty of Electrical Engineering, WUT. Since 2016 he has been Director of the Electrical Power Engineering Institute, Warsaw University of Technology. His research interests include power system planning, stability, and control.

e-mail: sylwester.robak@ien.pw.edu.pl

Janusz Bialek obtained his MEng (1977) and PhD (1981) degrees in Electrical Engineering from Warsaw University of Technology (WUT). Currently, he is Professor of Power and Energy Systems at Newcastle University, UK, and Full Professor at Skolkovo Institute of Science and Technology (Skoltech) where he was the founding Director of the Center for Energy Systems. Previously, Dr Bialek held Chair Professor positions at the University of Edinburgh (2003–2009) and Durham University (2009–2014). His main research interest is in the application of advanced mathematical methods to address techno-economic problems of the achieving low-carbon power systems.

e-mail: janusz.bialek@newcastle.ac.uk